Integrating Monitoring Tools to Meet Multiple Needs: Roles for Predictive Tools

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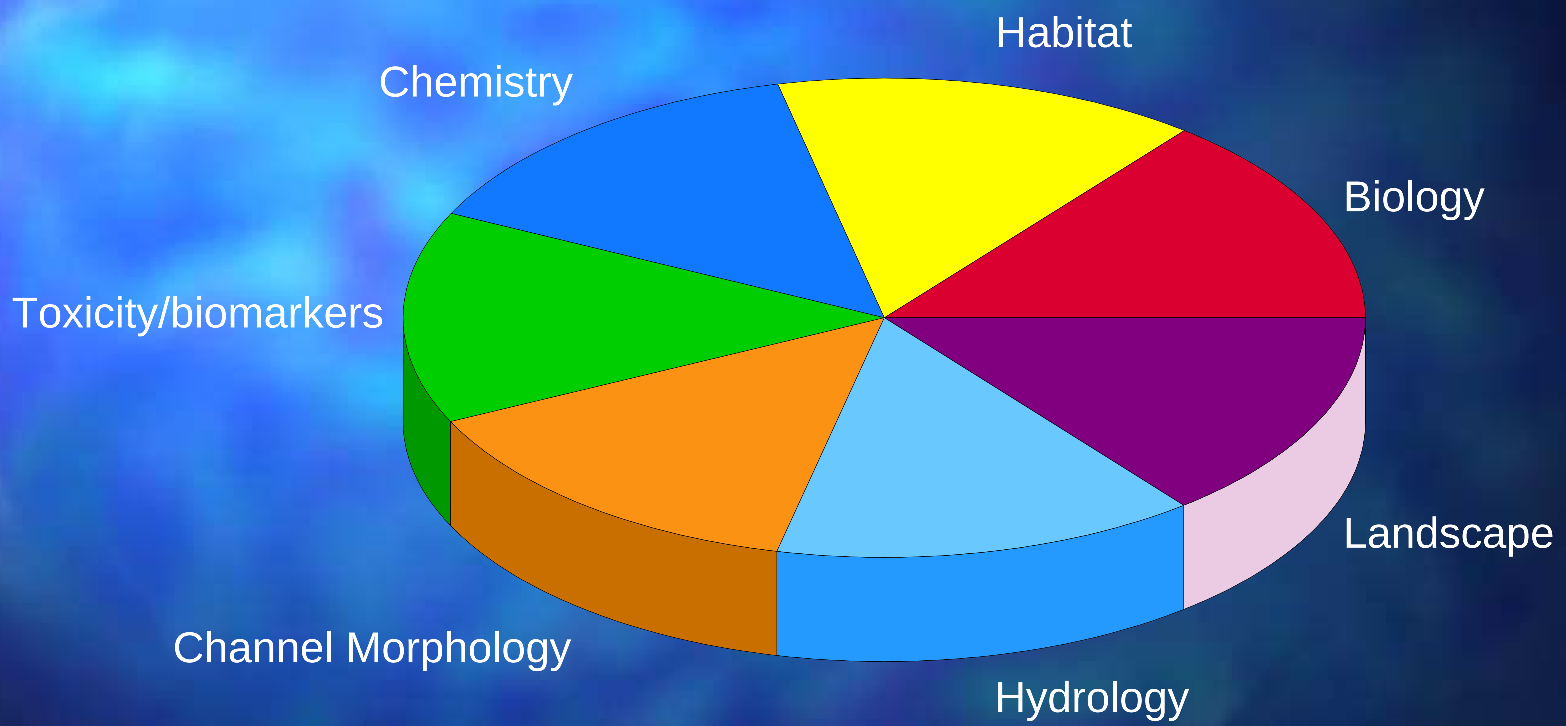
Atlanta, GA

May 2004

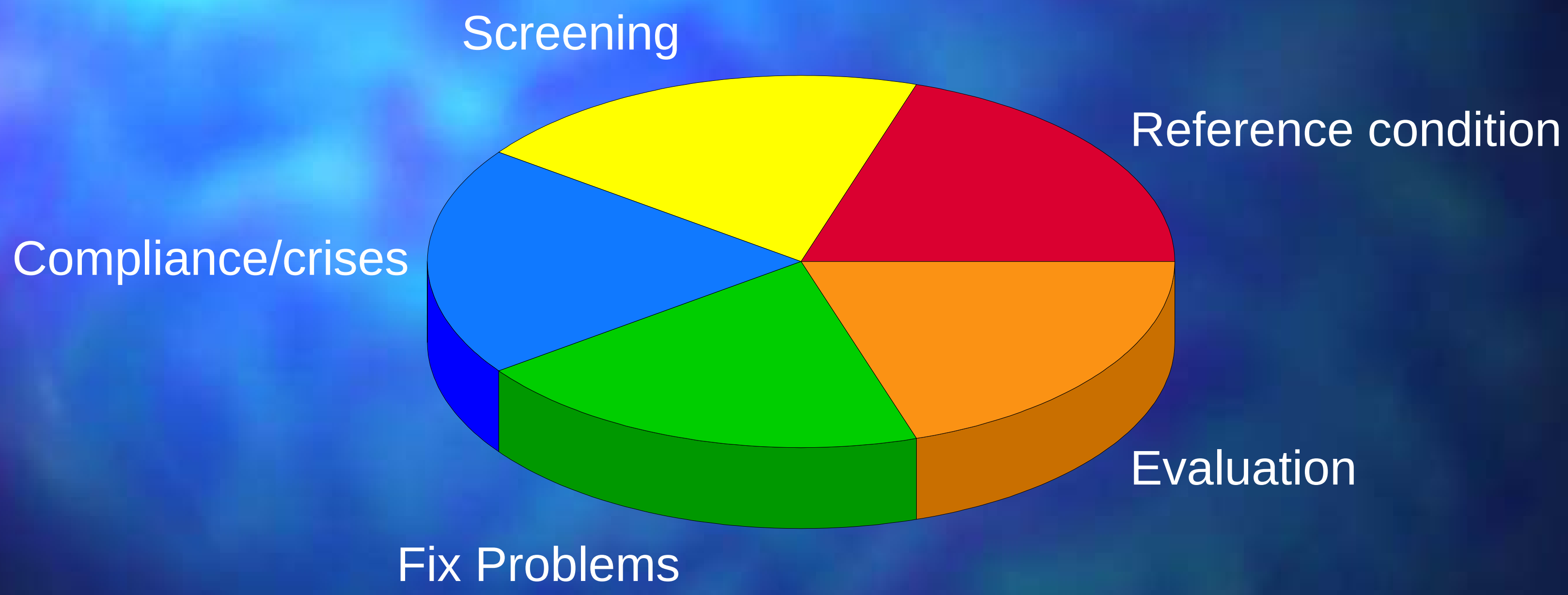
Tracy Mehan
8/2003

- “We cannot give a scientifically defensible assessment of what progress we are or are not making.”
- “We are essentially flying blind at a national scale.”

Dividing the monitoring pie by technique



Dividing the pie by key questions



Integrate Multiple Monitoring Tools

- Predictive tools
- Probability designs
- Targeted monitoring
- Innovative approaches

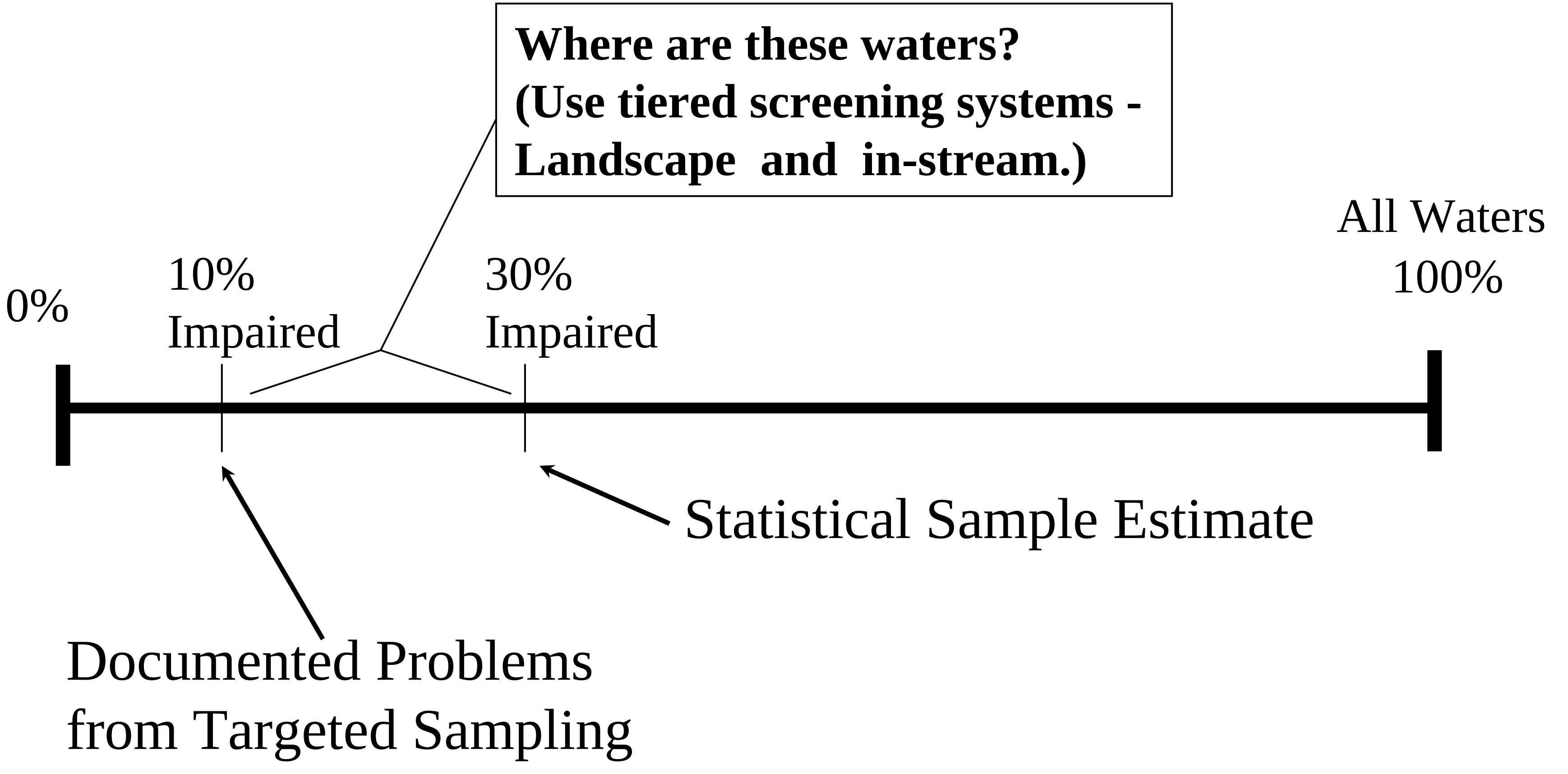
Examples of Predictive Tools

- Water quality models - process based
  - Data intensive
  - Cover small areas/site specific
- Landscape data, tools and screening techniques
  - GIS models - overlay
  - Models relating landscape factors to in-stream condition – statistical/empirical
  - “Wall to wall” coverage

Why Use Predictive Tools?

- Combine monitoring data and other information to help understand the relationships among hydrologic processes and ecosystem response
- Predict problems based on land use, point source discharges, and, non-point sources
  - Estimate level of vulnerability
  - Indicate likelihood of impairment
- Save resources by strategically targeting future monitoring and management actions

Need for Predictive Screening Systems to Identify Problems



Uses of Landscape Predictive Tools

- Extrapolate to waters lacking in-stream data
- Identify suspected problem areas
- Identify candidate reference (best) areas
- Target monitoring to confirm problems
- Target areas for prevention
- Prioritize TMDL and restoration efforts

More Uses of Predictive Tools

- Evaluate landscape stresses and problem causes for large areas
- Define & document human disturbance gradients
- Relate human disturbance to in-stream effects

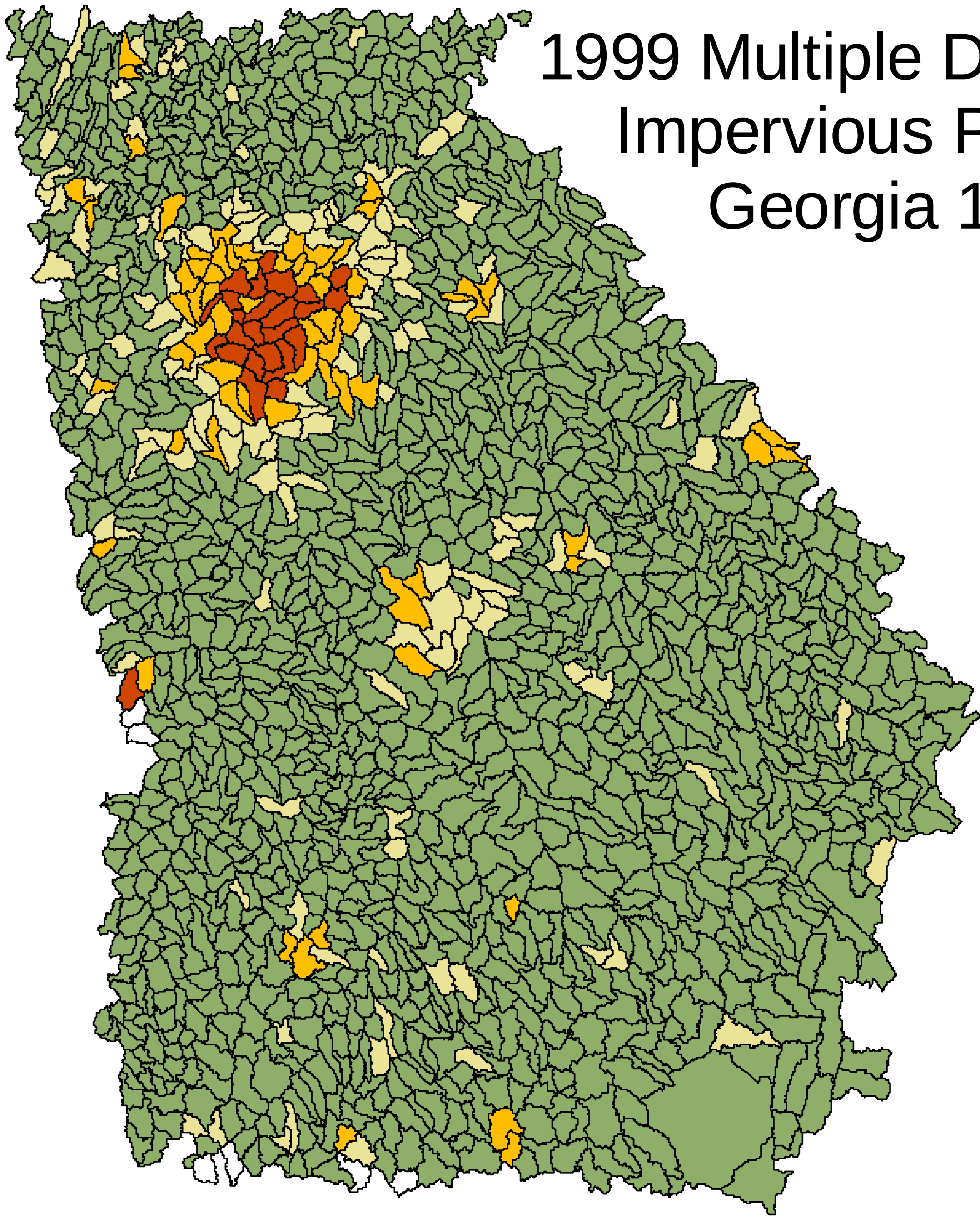
States' Multiple Needs

- Defensible, complete impaired waters lists (303(d))
- Protective Criteria/Standards (303 & 304)
- Prevent Future Problems (101)
- Implementation and Development of TMDL's

Defensible, Complete 303(d) Lists

- Empirical statistical models linking landscapes and in-stream response
  - Systematically identify potentially impaired waters
  - Efficiently target monitoring to confirm problems, causes and sources
  - Fill significant monitoring gaps
  - We can’t monitor everywhere, so we must monitor “smart.”

1999 Multiple Data Source (MDS) Impervious Percent Estimate Georgia 12 digit HUCs



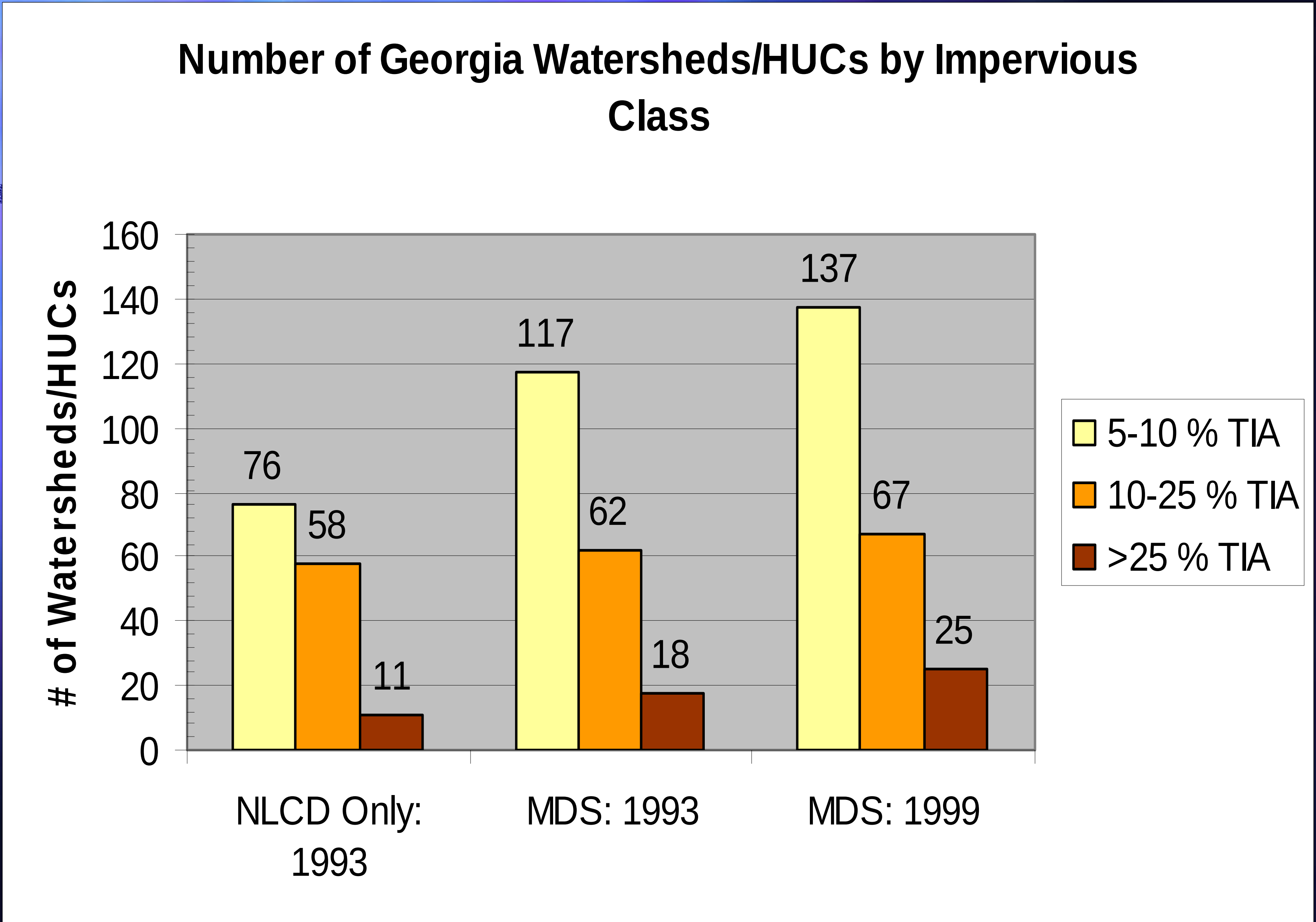
1999 MDS (%TIA)

- 0.22 - 4.999
- 5 - 9.999
- 10 - 24.999
- 25 - 60

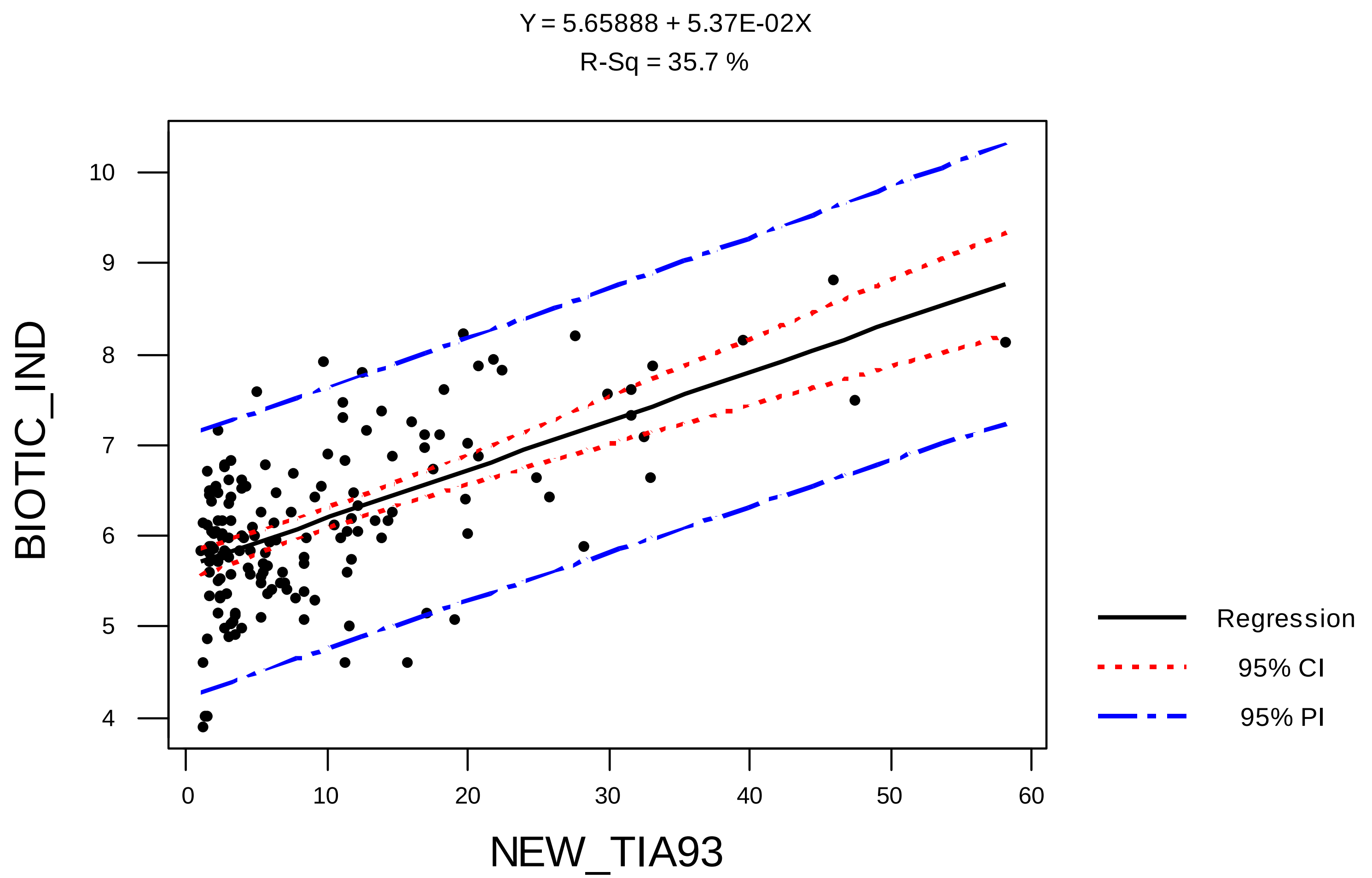
30 0 30 60 Kilometers

N
W E
S

EPA 2002


Number of Georgia Watersheds/HUCs by Impervious Class
# of Watersheds/HUCs
0
20
40
60
80
100
120
140
160
76
58
11
117
62
18
137
67
25
NLCD Only: 1993
MDS: 1993
MDS: 1999
5-10 % TIA
10-25 % TIA
>25 % TIA

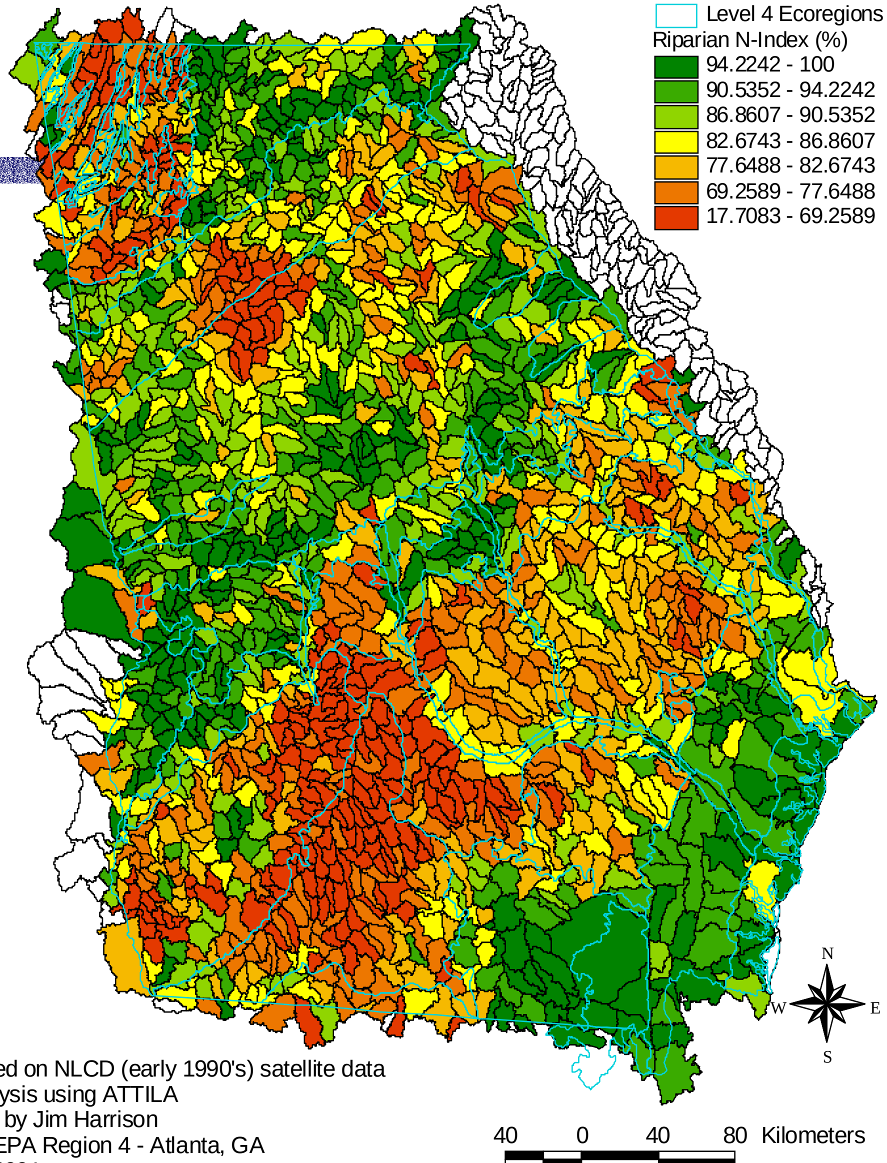
Biological Response Vs. MDS TIA



Protective Criteria/Standards

- Identify “reference” least impaired waters
- Identify other high quality waters
- Document gradients of stress/impairment
- Aid development of biological, habitat, nutrient, sediment and other criteria

Riparian N - Index (%) with Ecoregions
Georgia12 Digit HUC's

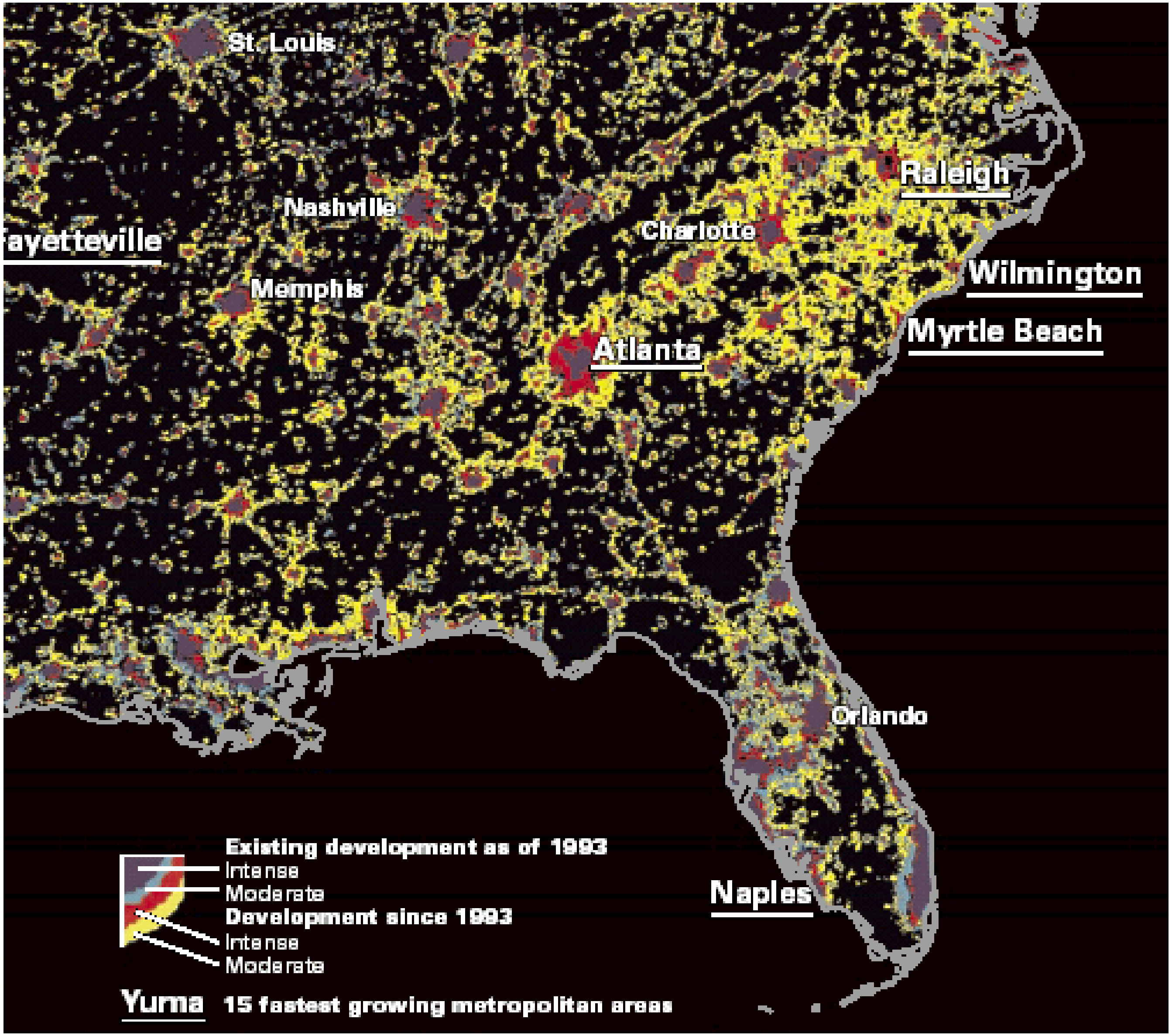


Based on NLCD (early 1990's) satellite data
Analysis using ATTILA
Map by Jim Harrison
US EPA Region 4 - Atlanta, GA
3/8/2001

Prevent Future Problems

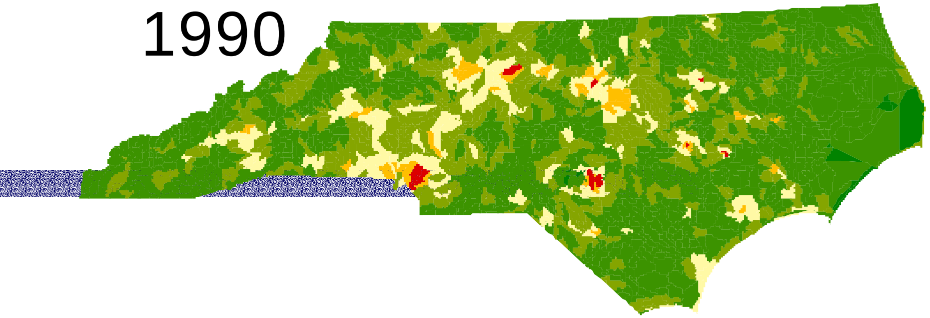
- Efficient, effective tools for identifying “at risk” waters
- Expanding urban areas
- “An ounce of prevention is worth a pound of cure.”

Close-up of **"Sprawl at Night: Seeing the Light"**

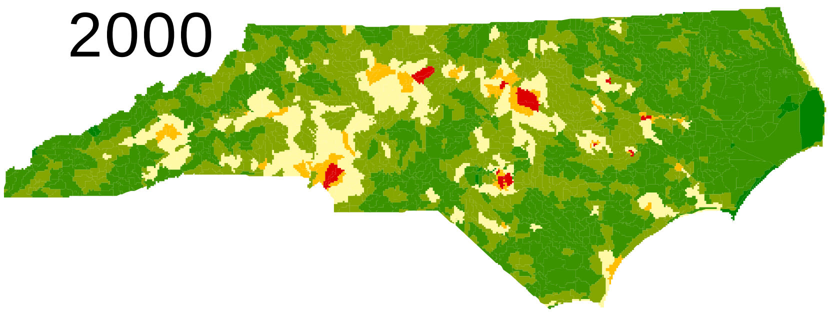


Estimated Population Density North Carolina 12 Digit HUC's

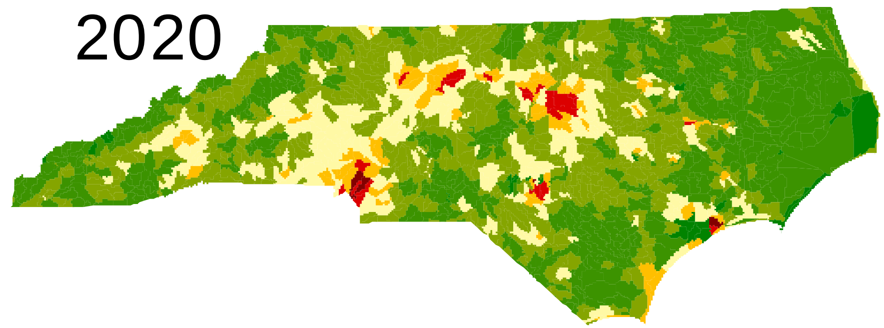
1990



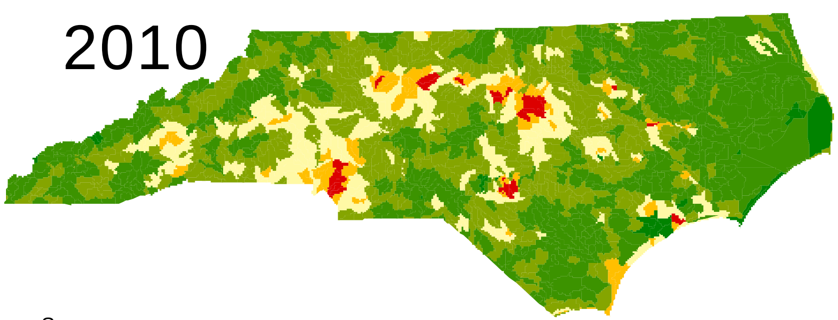
2000



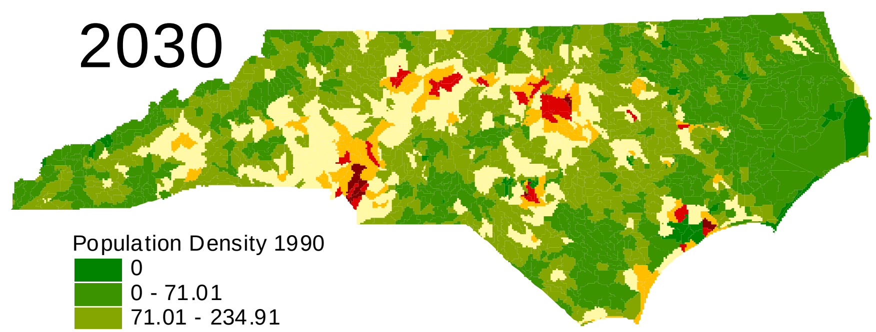
2020



2010



2030



Population Density 1990

- 0
- 0 - 71.01
- 71.01 - 234.91
- 234.91 - 737.15
- 737.15 - 1808.99
- 1808.99 - 3652.62
- 3652.62 - 9999.99

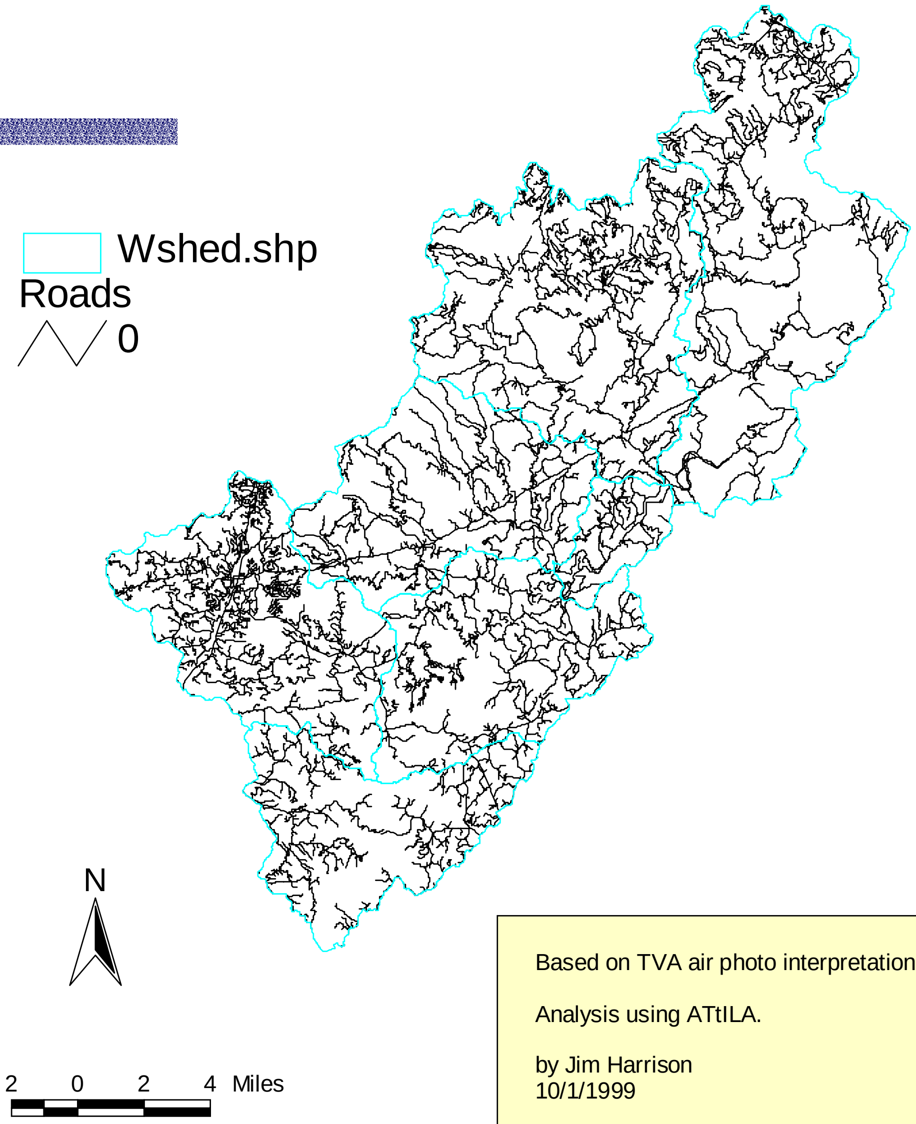
Sources:
US Census - 1990 and 2000 by block
NC Office of Planning and Budget,
Official County Projections - 2010, 2020 and 2030

US EPA
Jim Harrison
2/19/2004

Implementation and Development of TMDL’s

- Identifying sources and causes
- Constructing better load estimates - eg sediment and nutrients
- Better GIS data for sediment TMDL’s - landscape, urban areas, NPS loadings riparian zones, etc.

Roads
Chattooga Watershed

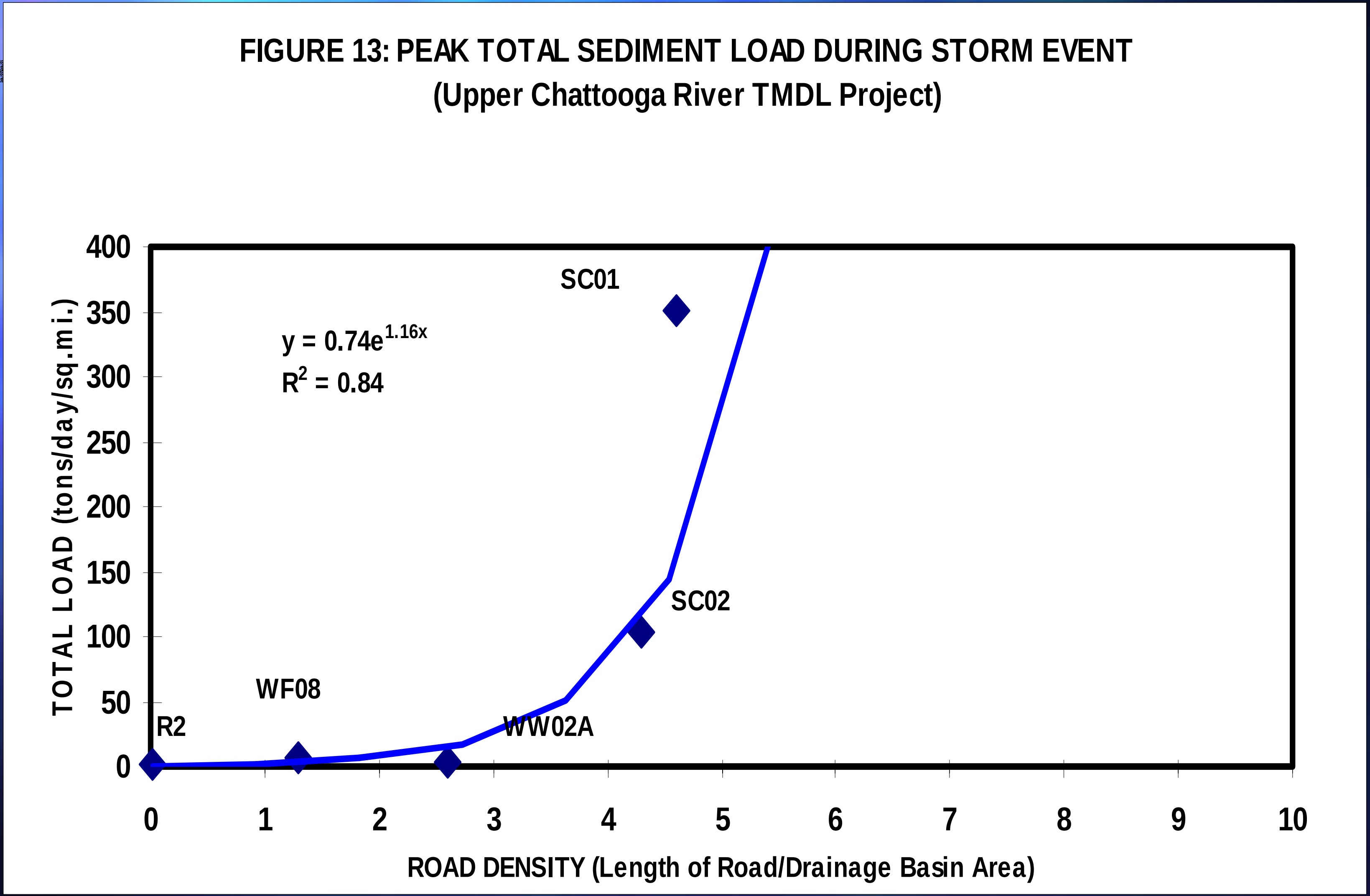


Based on TVA air photo interpretation

Analysis using ATtILA.

by Jim Harrison
10/1/1999

TOTAL SEDIMENT LOAD vs. ROAD DENSITY (Chattooga River TMDL Study)



Example Projects

- GA: Identification of reference waters and bioassesment program development - w/Columbus State U.
- MS: Identification of reference condition, bioassessment development and 303(d) list evaluation (Tetra Tech)
- AL: Screening for non-point source problem identification

More Example Projects

- FL: Human Disturbance Gradient (HDG) developed to relate landscape stress to in-stream biological conditions
- TN: Growth Readiness initiative used multiple data source impervious estimation - prevent water quality impairment due to future growth (w/TVA & others)

Region 4 Initiatives

- Impervious estimation using multiple data sources (ORD/Athens & R4)
  - GA Pilot: change from 1993 to 1999 (published)
  - Future condition pilot: NC to 2030 (in progress)
  - Region wide estimates:
    - Change: 1990-2000; future condition to ~2025/2030
    - Known accuracy compared to statistical air photo interpretation (under development)
  - Provides potential urban problem areas, load information for MS4 areas, aids development of urban BMP's

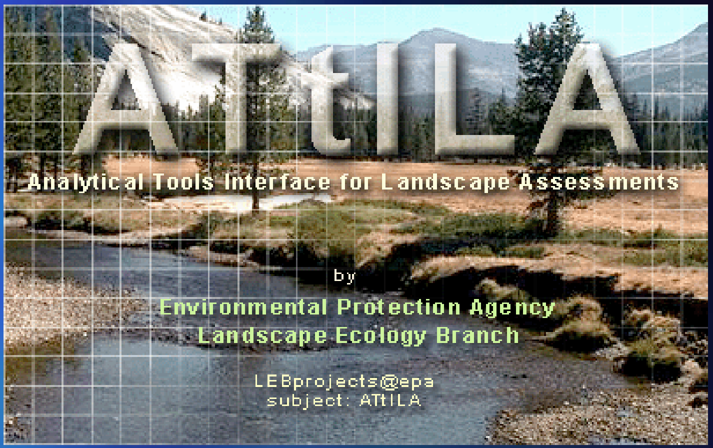
More Region 4 Initiatives

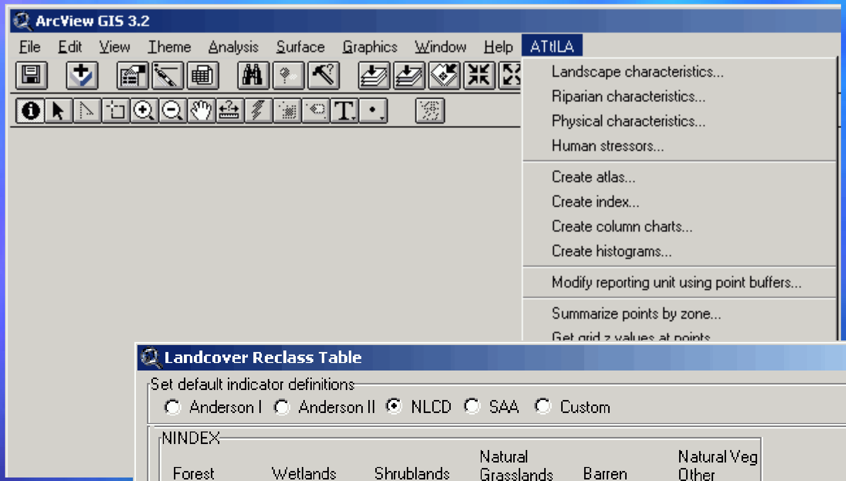
- Savannah River Basin REMAP
  - Initial proof of landscape relationships
  - Several published studies by ORD/Las Vegas
- Regional Vulnerability Assessment (REVA)
  - Collaborating with ORD/Las Vegas & RTP
  - R4 REMAP streams statistical network
  - State(s) stream statistical network(s)
  - Build landscape relationships to extrapolate condition estimates
  - Target present and future vulnerabilities

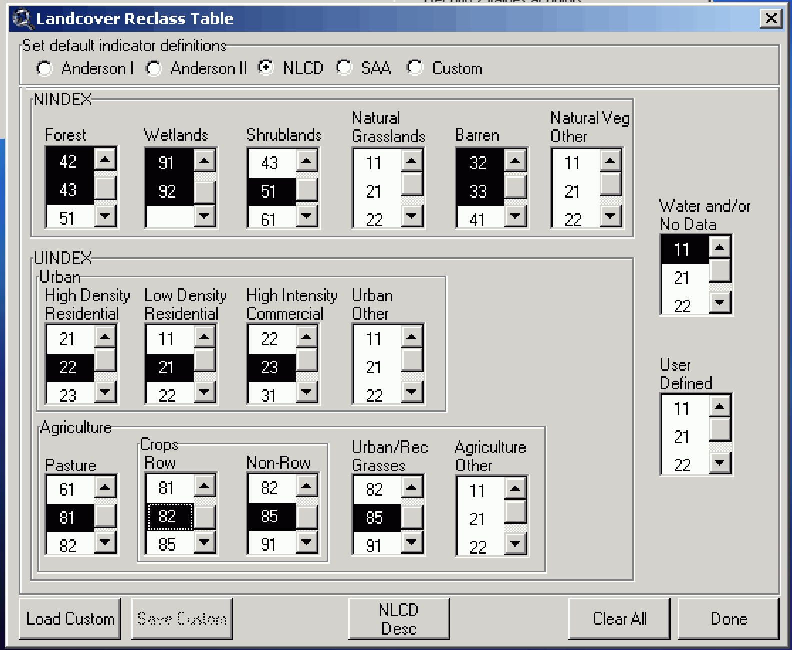
Other/Tools/Technical Assistance

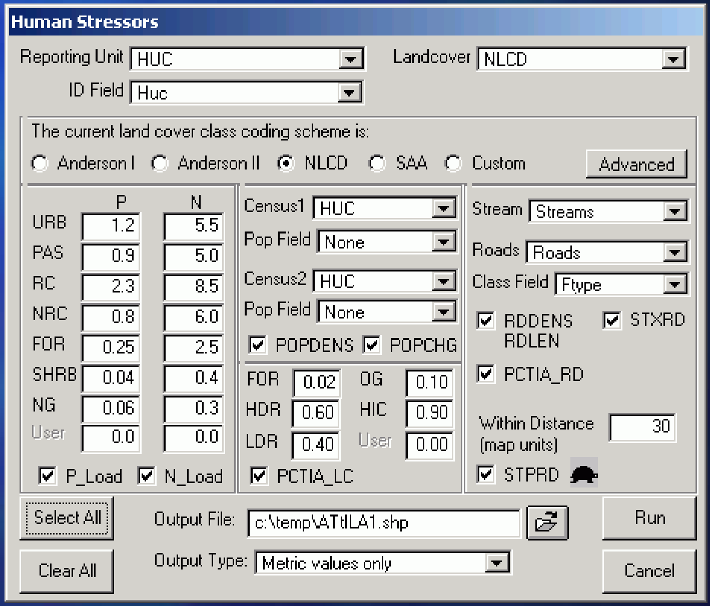
- ATTILA landscape software
  - Analytical Tools Interface for Landscape Assessment (by ORD/Las Vegas)
  - 50+ landscape factors, near release
- Region 7 REMAP Great Plains Studies
  - Numerous published studies
- Region 3 MAIA & REVA

ATtILA Landscape Factors Software

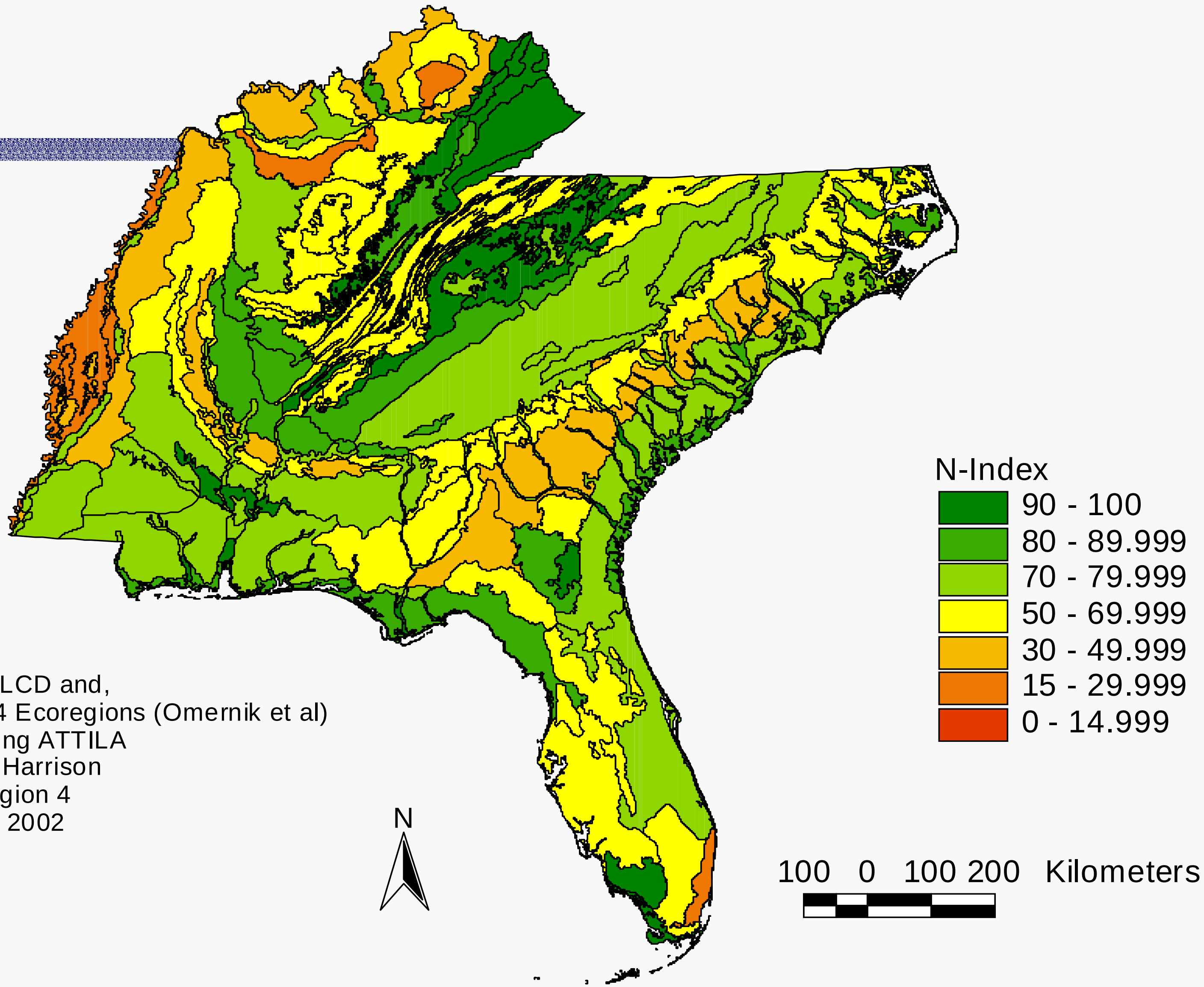








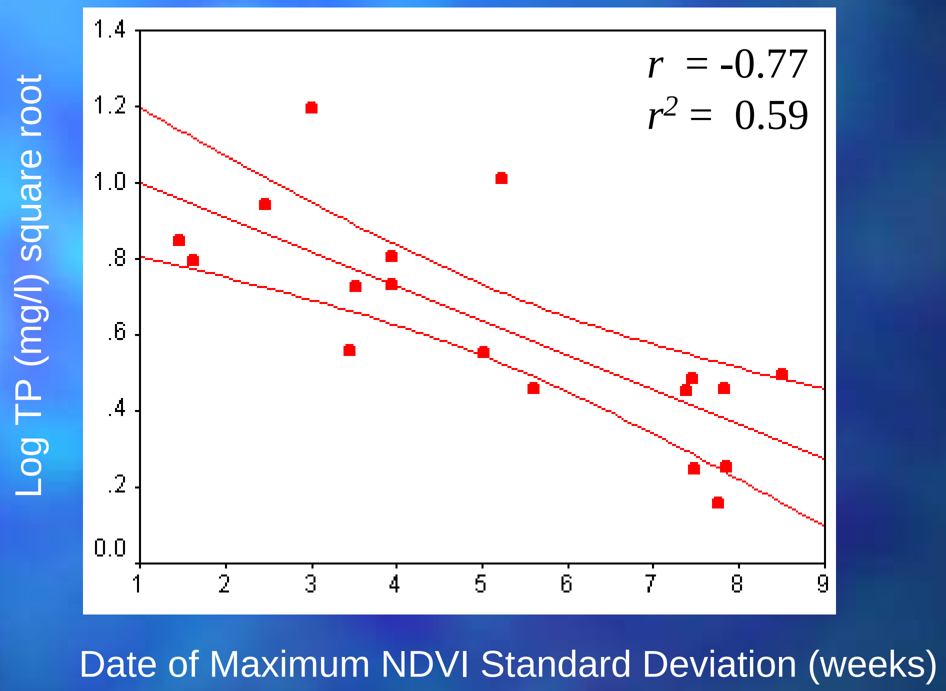
Natural Land Cover Percent (N-Index): Omernik Ecoregions (Level 4)



Based on NLCD and,
draft Level 4 Ecoregions (Omernik et al)
Analysis using ATTILA
May by Jim Harrison
US EPA Region 4
January 28, 2002

Map Application - Total Phosphorous in the Central Great Plains

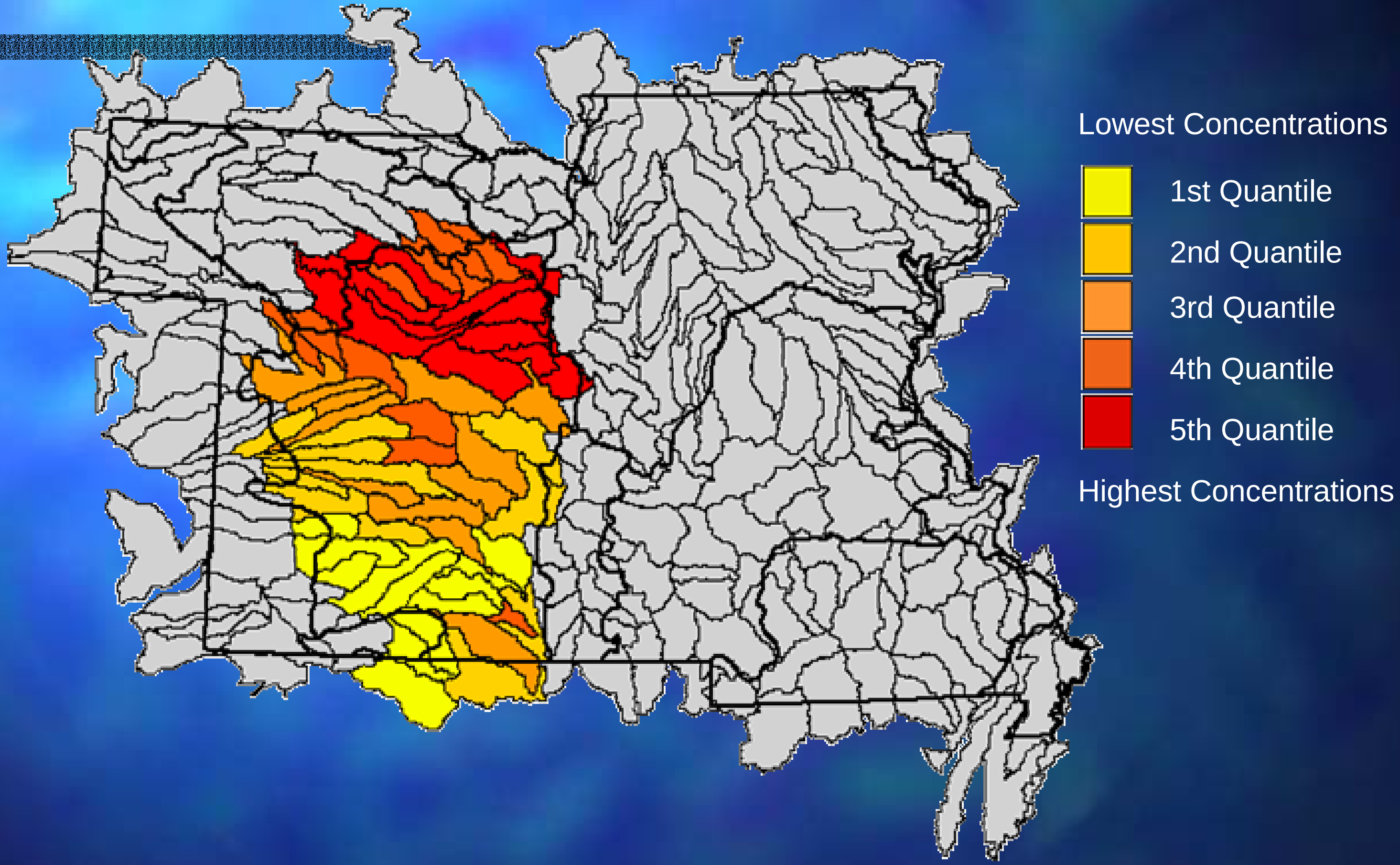
Scatterplot with 95% confidence interval shown around regression line



Regression Equation:

TP = 1.092 + -9.08E-02 x date of max NDVI sd
Adjusted r^2 = 0.56

Potential Total Phosphorous - Central Great Plains



National Strategy

- Two key innovative tools
  - Statistical networks
  - Landscape models
- Landscape relationships connect probability samples with targeted monitoring

Tracy Mehan (AA for Water) (1/2003)

- “EPA and USGS are developing landscape models that will predict the potential for water quality problems based on landscape characteristics. ORD’s landscape ecologists have demonstrated that empirically derived statistical landscape modes can be used to predict locations of water quality impairments and future impairments. Unlike conventional ambient water quality monitoring which has limited geographic coverage, landscape analysis uses “wall-to-wall” geographic data derived from remote sensing (primarily satellite data) and can fill-in the gaps between water quality monitoring stations.”

Last Slide/Extras Follow

Standards Strategy (2003)
Future Priority Strategic Actions

- Promote increased use of ecological criteria and watershed-scale indicators as measures of healthy water bodies. Combining elements of chemical, physical and biological criteria in ecological risk evaluations can help define "ecological criteria" as measures of healthy water bodies. Such criteria and indicators have the potential of estimating the total response of a water body to potential alterations and stressors and identifying the appropriate scale for remediation, e.g., remediation in the stream along the riparian corridor or watershed-wide. Once ecological indicators are established for a water body, landscape-scale stressor-response relationships can be determined and used as a basis for the development of watershed-scale indicators and as predictive tools for watershed management. These new scientific tools could help states and tribes make water quality standards more ecologically-based and could set the stage for better watershed management. OST could focus on the integration of traditional criteria into ecological criteria. ORD could research and develop watershed-scale indicators and indices of watershed integrity. As useful approaches emerge, OST and ORD would develop case studies to illustrate how ecological criteria and watershed indicators work and would develop methods to assist states and tribes with their own implementation.

Streamlined Monitoring - Using the Tools Together